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(54) Name of invention Endoscope

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Continue on the last page

Statements of claims

1. Invention name

Endoscope

2. Scopes of patent claims

The endoscope that includes the capsule housing, the observing means, the first means to selectively generate inertia on different directions on the housing, the second means to generate inertia from the first means and switch the inertia direction, the third means to receive signal to control the second means, the fourth means to transmit telemetry of image signal from the observing means above and signal to the third means, and used by floating the housing above in non-gravity space or minor gravity space.

3. Detailed descriptions of the invention

[Application area and industries]

This invention is related to the endoscope used in minor or no gravity space.

[Conventional technology]

The endoscope to observe internal surfaces of the body cavity, engine, pipe and others have been developed and being applied in various proposals.

However, the conventional endoscope is proposed to use on Earth. Therefore, it is affected by gravitation force, and requires large manipulating power to change view direction or moving direction through remote control. Therefore, it is necessary to have a large driving power unit and operation system. In addition, the structure is complicated and of large size.

[Topics of solution in this invention]

However, now we have further opportunity to live in space through rockets or spacecraft. In space, it is vital to inspect human bodies and equipment as well.

In this instance, the gravity will be lower the larger distance from the Earth's surface, and reach almost non-gravity environment on the final stage. Operation of endoscope in such environment must be discussed under idea different from conventional thoughts.

But no endoscope has ever been manufactured.

This invention is aimed at topics above. Its target is the endoscope that is easy to inspect, lower in penetration impact and larger in observation scope that can be used in minor gravity or non-gravity space.

[Means and action to solution of the topics]

In order to solve the topics above, the following shall be established. That is, the endoscope that includes the capsule housing, the observing means, the first means to selectively generate inertia on different directions on the housing, the second means to generate inertia from the first means and switch the inertia direction, the third means to receive signal to control the second means, the fourth means to transmit telemetry of image signal from the observing means above and signal to the third means, and used by floating the housing above in non-gravity space or minor gravity space.

[Application example]

Figure 1 to figure 3 show the first application example in this invention.

In figure 1, 1 is the endoscope housing where the front wall tip and rear wall tip is sphere, the central trunk is cylindrical capsule shape. The inside of housing 1 includes various parts that will be mentioned later. Next, the endoscope shall float independently in minor gravity or non-gravity space.

The tip wall center of 1 is equipped with the objective lens 2 as the observing means. Inside of the objective lens 2 has a solid image sensor e.g. CCD 3. The CCD 3 has CCD driving circuit 5 that is controlled by the controller 4. Next, CCD 3 has observing means to convert viewfinder image to image signal through the objective lens 2. This signal will be transmitted to the receiver 7 outside of the body through image transmitter 6. Signal received by the external receiver 7 will be converted into image signal through photographing circuit 8 to display the image of the body inside on the monitor 9.

In addition, the tip wall of the housing 1 has LED 11 as illuminating means on top and bottom of the objective lens 2.

Furthermore, the rear tip of the housing 1 has many nozzles 12 directed in inclination to rear end under a constant spacing. Each nozzle 12 is connected to tank 14 by means of individual valve 9. The tank is filled with compressed air. Each valve 9 will open or close under signal from the valve controller 16 that is operated through the receiver 15. The receiver will move under signal from the transmitter 17 outside the body.

Telemetric transmission of signal from the image transmitter 6 to the receiver 7 outside the body, or from the outside transmitter 17 to the receiver 15 will be under controllable environment e.g. wireless or ultrasonic wave. In addition, power supply for CCD driving circuit 5, LED 11, valves 9, receiver 15, valve controller 16 and others will be given from the battery (rechargeable) 13.

Furthermore, it is shown in figure 1 that the tank 14 is located in the center of the housing 14. There are image transmitter 6 and controller 4 on the tip of tank 14 of the housing 1. The top of the transmitter and controller is located power supply 13. In addition, the receiver 15 is on the rear inside of the housing 1.

Next, we will describe about performance of the endoscope. In minor gravity or non-gravity space, the housing 1 will float in the body. In this state, we will change position or move the housing 1 by manipulating with telemetric signal of the transmitter outside the body 17 to the receiver 15 in the endoscope. Valve controller 16 will repeat opening angle of valve 9 instantaneously based on signal arriving at the receiver 15. Therefore, compressed air in tank 14 will be released discretely. Reaction force when compressed air is instantaneously released from nozzle 12 will give inertia

(propelling force) to the housing 1. Next, cruising with inertia or change in direction and distance of the housing 1 will relate with jet direction from nozzle 12. That is, we can change both position and direction of the housing 1. Furthermore, figure 3 shows relationship of pulse driving signal, valve release angle (release time of compressed air) and moving distance of the housing 1.

Therefore, this endoscope can change direction and location through movement of the housing 1 in minor gravity or non-gravity space. That is, it is simple to inspect with low penetration and larger inspection scope.

Furthermore, the outside of the housing 1 will have various distance measuring sensors. If the housing moves with inertia, the sensors will measure distance from the housing 1 to the wall to facilitate position monitoring. In addition, sensors on the top-bottom and the left-right of the side view of the housing 1 will evaluate change of distance from the wall, and maintain the position without any change, or find direction and position of the housing 1 from data of change, and can give counter-attack inertia in reverse direction etc.

Figure 4 and figure 5 show the second application example of the invention. In this example, piezoelectric sensor 21 to emit ultrasonic wave is installed on the rear end as well as the top-bottom and the left-right position on the back end of the housing 1. The oscillated ultrasonic wave will give inertia (propulsive force) to the housing 1. In addition, the housing 1 inside has a piezoelectric sensor driving circuit 22 that is operated by signal from the receiver 15 and will drive the piezoelectric sensor 21 selectively. In the example 2, ultrasonic wave will drive and control position of the housing 1. Other compositions and functions are identical to those in the first example.

Figure 6 and figure 7 show the third application example of this invention. In this example, fan 25 is installed on 3 directions and rear position on the back side of the housing 1. The fan 25 will be driven by motor 26. In addition, the housing 1 inside has a motor driving circuit 27 that is manipulated with signal being received through the receiver 15.

In this example, selective driving of fan 25 will sir and spray the ambient fluid. In contrast, the housing 1 will be controlled for direction and position by means of the fluid. Other compositions and performances are identical to those in example 1.

Figure 8 to figure 9 are the fourth application example of this invention. In this invention, cable 31 made of flexible tube stretches out of the rear end of the housing 1. The cable 31 contains energy transmission line 32 and pressurizing tube 33 that penetrates through. The energy line 32 will connect the energy controller 34 in the housing 1 and the external power supply 35 outside the body. Pressurizing tube 33 will connect reserve tank 36 in the housing 1 with the pump 37 that is outside the body. Furthermore, the outer surface of the housing 1 has various nozzles 38 with different directions or position. For instance, the relatively front of the top-bottom and left-right position of the housing 1 has nozzle 38 on vertical direction, the relatively rear surface has various nozzles 38 on inclining outward direction at equal angular spacing. Next, the nozzle 38 connects with the reserve tank 36 by means of each solenoid valve 39. The reserve tank 36 is usually fed with pressurized fluid from the external pump 37 through the pressurizing tube above. The solenoid valve 39 will be selectively opened by the valve controller 40 on the housing 1 as well. In addition, the valve controller 40 is manipulated by signal being received by the receiver 15. Other compositions will be identical with those of examples above.

In this example, specified solenoid valve 39 is released as desired through the valve controller 40 that is manipulated with signal in the receiver 15, pressurized fluid from the reserve tank will be fed to the nozzle respectively. Next, reaction force at this moment will give propulsive force and position control to the housing 1. In addition, energy to each part will be received from the body outside power supply 35 through the energy transmission line 32 and arrive at the energy controller 34. Other functions will be identical to those in example 1.

Furthermore, the endoscope can be controlled for direction and position with inertia from magnetic force. That is, the housing will be magnetic substance that floats in magnetic field. When the magnetic field is changed in 3-dimensions, specific inertia will be given to the housing 1.

Figure 10 to figure 13 show the fifth application example in this invention. In this example, the unit is self-crawling inspection device in artery as the medical micro-robot. That is, there are many capsules 41, 42, 43 in one row as shown in figure 10. The tip of the front capsule or housing 41a has the ultrasonic photographing sensor 44 with two dimensional viewfinder in the forward direction. The circumferential surface of capsule 42 on the middle will have the ultrasonic sensor 45 to take ultrasonic layering image on the cross-section of the artery 46. Next, capsule 43 on the last end has a telemetric function part. In addition, cable 47 for collecting image is led from the rear tip of the capsule 43.

Furthermore, various self-cruising legs 48 are located at constant angular spacing on the circumference so as to stretch out to the inclining forward direction of the circumference on the front of the front capsule 41. The self-cruising legs 48 has electro-conductive layer 52 with relatively large resistance for thermoelectric of band member 51 that is formed with dual directional shape memory alloy as shown in figure 12 or figure 13. The conductive layer 52 can be formed with nickel that keeps loop shape by linking from one end to the other parallel end 52a, 52a. In addition, the part 52a, 52a will be thinner step by step from the one end to the other end. Furthermore, both surfaces of the conductive layer 52 will be coated with electrical insulating film 53. Next, the thinner end of part 52a, 52a on the layer 52 will be folded and bended and fixed on the capsule 41 on the front end as shown in figure 11 ①. To motivate the self-cruising legs 48, the conductive layer 52 will be fed with power supply to heat under electrical resistance. Therefore, the tip of conductive layer 52 will be heated to high temperature. At first, the tip A will bend as shown in figure 11 ②. Next, heating will continue and part B will bend as shown in figure 11 ③. By bending from point A to B, the self-cruising legs will kick back. In addition, after kicking of the legs 48, natural culling will recover state in figure 11 ① if power supply is interrupted. Furthermore, if part 51 is made of one-directional shape memory alloy, elastic recovery force of parts 51 and insulating film 53 will return state in figure 11 ① after stopping the power supply.

Therefore, if the self-crawling inspection unit in the artery is kicked by various self-cruising legs 48 in capsule 41 on its tip, the self-cruising legs 48 will kick the artery wall 46 to the back, and move the capsule 41 forward. Next, ultrasonic photographing sensor 41 in the front capsule 41 will observe 2-dimensional image on the front, and will get ultrasonic layering image of cross-section of the artery by using the ultrasonic sensor in the middle capsule 42. Next, these manipulations or observing data will be processed by telemetric function of the capsule 3 on the back. These data will be collected by placing cable 47.

Furthermore, in case the self-cruising legs 48 cannot kick, the legs 48 will stretch forward in inclining position so that the tip will touch with the internal wall of the artery 46, and will hold capsules 41, 42 and 43.

This type of self-crawling inspection unit has simple structure and is precise; it is applicable with artery, vein and other fine pipe or duct. In addition, structure of the self-cruising legs can be different from those above. It can be made of bimetal materials as shown in figure 14 to figure 16. That is, nickel layer 56 for thermoelectric heating loop will be placed on one side of the resin band 55. The nickel layer 56 will be coated with electric insulating film 57. However, when the nickel layer 56 is heated from power supply, straight part in figure 14 ① will bend as in figure 14 ②. That is, jumping action can be gained.

In addition, stopping power supply above will recover the material to shape as in the figure 14 ①. That is, microscale of the self-cruising legs 48 will give rapid response.

In addition, bimorph piezoelectric device can be used as the self-cruising leg. For instance, figure 17 and figure 18 show such application. In this example, one side of the bimorph piezoelectric device 58 will have various legs 59 in inclining direction to the rear with some spacing. In general, it is as shown in figure 17. However, by repeating the bimorph piezoelectric device 58 with curve in figure 18 and figure 19, each leg 59 will be vibrated. Therefore, this motion will move the capsule backward or forward like a crawling cat.

Figure 20 shows the sixth application example of this invention. This example is related to medical micro-robot of self-crawling inspection unit inside intestine. That is, various capsules 61, 62, 63 are linked in one row. The tip of the housing 61a of the front capsule 61 has objective lens to observe on the front, and image will be recorded with a photographing sensor inside (not shown in the figure). In addition, the vicinity of the objective lens 64 contains illuminating window 65 and tool penetrating hole (not shown in the figure). The middle capsule 62 will fill the sampling specimen. Its front tip will have various holes 66 to collect specimen. That is, the specimen will be sucked and collected. On the back capsule 63, there is a telemetric unit.

Furthermore, the bottom surface of front capsule 61 that is on the rear end will be a self-cruising leg 67 for moving forward. The lower surface of the last capsule 63 will have a self-cruising leg 68 for driving backward. The self-cruising legs 67, 68 can be any types as mentioned above. However, the forward and backward mechanism will have reverse kicking direction.

Therefore, if kicking motion of self-cruising legs 67 on capsule in this self-crawling inspection unit for intestine is applied, the capsule 61, 62, 63 will move forward. By kicking with the self-cruising leg 68 on the rear capsule 63, the capsules 61, 62, 63 will move backward. In addition, illumination in the front capsule will project to facilitate observation, and data processing will be made through manipulator 69 from the hole of processing unit. In figure 20, snare wire 70 will be used to cut off polyps 71. The middle capsule 62 will suck and collect specimen, and collect out. Next, these manipulations and observation data will be processed through telemetric function of the rear capsule 63. In addition, since the self-cruising leg 68 for retreat is installed, it is unnecessary to install cable for collection of those data.

Figure 21 shows the seventh application example of this invention. In this example, it shows the self-crawling inspection unit for intestine as the medical micro-robot. That is, this unit contains two front and back capsules 72, 73 that are linked. Tip of the housing 72a of the front capsule 72 has objective lens to observe front view. Its photograph will be recorded with the photographing sensor inside that is not shown in the figure. In addition, vicinity of the objective lens 74 will have illuminating window 75 and tool hole (not shown in the figure). The circumference of housing 73a of the rear capsule 73 will have ultrasonic sensor 76 to collect ultrasonic layering image of the tissues. In addition, the back of capsule 73 will be hole for intake and outtake of water. Next, at least one of the two capsules 72, 73 will have the telemetric unit.

Furthermore, the lower surface of capsule 72 on the front will have various position-holding legs 78. The position-holding legs 78 will expand outward to stop the capsule 72 as required position. The legs 78 can be either of those mentioned above. Vicinity of the rear capsule will be balloon 79 that will inflate to touch with the intestinal wall 80.

Therefore, capsule 72, 73 of the self-crawling inspection unit for intestine will be inserted through peristaltic movement of the intestine 80.

In addition, information on the manipulations and observations will be processed with the telemetric function above.

Figure 22 shows the eighth application example of this invention. In this example, it is related with self-crawling capsule for cavity of fine artery 81 as the medical micro-robot. That is, the self-crawling capsule 81 will have flexible slant housing 82. The tip of the slant housing 82 will have observing objective lens 83a and illuminating window 83a. In addition, on many locations of the circumference of the slant housing 82 with some front and back spacing will have the self-cruising leg 84 as mentioned above. Next, by activating the self-cruising leg 84, the slant housing 82 will move inside the fine artery through self-crawling. In addition, the rear end of the self-crawling capsule will have flexible cable 86. The cable will transmit illumination, photography image signal (or optic image) and others to the outside.

Next, if the unit is inserted in to the urinary duct 87, the self-crawling capsule 81 will enter the duct 87 through channel 89 of the endoscope 88. If the unit is manipulated to crawl after entering the duct, it will move autonomously within such urinary duct.

Figure 23 to figure 26 show the micro-robot to stay a long time in the body for internal healing. In figure 23, two biological micro-robots, that is, blood collecting robot 91 and bone curing robot 92 will be shown. The blood collecting robot 91 will collect blood of the patient and analyze compositions. The bone healing robot 92 will use the compositions to synthesize bone matter to cure the patient effectively.

In practice, the two robots 91, 92 have capsule housings 91a, 92a with propulsion unit 95 with position control jet opening 94 and forward jet opening 93. Furthermore, the capsule 91a, 92a will have illuminating window 96 and observing window 97 to observe inside the body. Observation data and jet control data of the jet openings 93, 94 will be controlled by commands from the external manipulation units 98, 99 outside the body by means of telemetry function in the capsule housing 91a, 92a. In blood collection robot 91, needle shape blood collecting manipulator 101 is installed on the tip. And the capsule housing 91a has blood storage tank 102, and composition separating unit 103. The propulsion unit 95 and the blood collecting manipulator 101 will be manipulated by telemetric transmission media in the external manipulation unit 98 e.g. wireless signal. The composition separating unit 103 will separate compositions of blood e.g. calcium, phosphorus, oxygen etc.

Bone healing robot 92 has manipulator for bone removal 104, bone curing manipulator 150, and artificial bone outlet 106. The capsule housing 92a in the bone healing robot 92 will have the artificial bone release unit 108 that includes bone synthesis unit 107 and pump or others. Propulsion unit 95, bone removing manipulator 105 will be manipulated by means of telemetric transmission at the manipulation unit 99 outside the body. The bone synthesis unit 107 will create calcium phosphate matter from the separated substances above.

Composition separating unit 103 and bond synthesis unit 107 of bone healing robot 92 of blood collecting robot 91 will be linked with substance conveying pipe 109.

The system block diagram of blood collecting robot 91 and bone healing robot 92 is shown in figure 24.

Therefore, the blood collecting robot 91 and the bone healing robot 92 will be left for a long time in the body to collect blood from the artery 100 of the patient by means of the blood collecting robot 91. At the same time, necessary compositions in the blood will be separated, fed to the bone synthesis unit 107 of the bone healing robot 92, to synthesize artificial bone as necessary. In addition, the bone healing robot 92 will

cut injured bone 110 of the patient with the bone removing manipulator 104, and the bone binding manipulator 105 will heal the affected zone with artificial bone from the artificial bone outlet unit 108.

Power supply of the robot 91, 92 is also obtained in the body. The first means is shown in figure 25. That is, the composition separating unit 111 of the blood collecting robot 92 will separate glucose ($C_6H_{12}O_6$) and oxygen (O_2) from collected blood, and store in tank 112, 113, respectively. Next, if energy is required, the compositions will be oxidized with the oxidizing decomposition unit 114 to give electric power. The electric energy may drive motor 115 and others to manipulate the propulsion unit 116. Therefore, energy source will be obtained in the body, and it is unnecessary to obtain outside. That is, the robots will be installed inside the body for a long time.

In addition, power source in the body can be internal combustion system. Figure 26 shows an example in this instance. That is, the composition separating unit 121 to separate oxygen from the blood and the oxygen storage tank 122 will be installed. In addition, the composition separating unit 123 will separate methane gas from stool, and the methane storage tank 124 will be provided. Oxygen and methane gas will burn to motivate the internal combustion engine 125. Therefore, in case energy is required, the internal combustion engine 125 will be activated to burn methane gas and emit heat energy. Therefore, it can drive the propulsion unit 126 and others.

Furthermore, the example above is related to bone curing, but healing of artery is also applied similarly. Figure 27 shows artery healing robot 130 in this instance. The blood collecting robot 131 is similar to those mentioned above.

The artery healing robot 130 will have handle of artificial sheet 132, sheet manipulator 133, mending needle manipulator 134, outlet opening 136 of protein thread 135, outlet opening 137 of artificial sheet (protein film) and others on the capsule housing 130a. In addition, it will have illuminating window 138 and observing window 139. Next, the capsule housing 130a will have the propulsion unit that includes forward jet opening 141 and position control jet opening 142.

Furthermore, the inside of the capsule housing 130a will have protein film synthesis unit 145 to produce protein by using compositions from the blood collecting robot 131 through transportation pipe 143, protein film outlet pump 146, protein thread synthesis unit 147, and protein thread pump 148 as shown in figure 28.

Therefore, the blood collecting robot will separate protein from collected blood. In robot for artery healing, the protein will be fed to synthesize artificial sheet 132 and protein 135 as protein film, and feed out by pump 146, 148 as necessary. These motions will be controlled by means of telemetric transmission e.g. use of wireless signal.

The artery healing robot 130 will heal the duct by using sheet manipulator 133 and mending needle manipulator 134 to sew artificial sheet 132 on blood duct e.g. artery or vein. Therefore, consumable material of artificial sheet 132 and protein thread 135 will be available in the body and supply from the outside is unnecessary. Therefore, the robot can operate in the body for a long time. By the way, energy source will be as mentioned above.

Figure 29 to figure 31 show another type of medical robot inside the body. That is, this medical robot will have various separated micro-robots 151, 152, 153. The outside of each robot 151, 152, 153 will have cruising legs 154 as mentioned before. By manipulating the cruising leg 154, the robot will move inside the artery cavity independently. The cruising leg can be rigid hair inclining on ring type piezoelectric sensor array

on the circumference of the micro-robot housing. The legs will move forward or backward based on vibration pattern of the piezoelectric sensor. In addition, the self-cruising legs as mentioned before can be applied as well.

In addition, the micro-robot 151, 152, 153 will have receiver 155 for telemetric transmission, and driving circuit 156 for cruising leg 154. Furthermore, the first micro-robot 151 will be equipped with illuminating means 157 from LED etc., observing means 160 from objective lens 158, photographing sensor 159 or others, transmitter 161 and inductive unit 162. Photography signal from the photographing sensor 159 will be transmitted to the receiver by means of the transmitter 161. In addition, inductive unit 162 will transmit inductive signal by generating electromagnetic wave to micro-robot 152, 153, which will be mentioned later. The second micro-robot 152 will have chamber 164 to contain the manipulator 163 for processing in the body, driving motor to control the manipulator 163, open-close cover of ports of chamber 164 and others. The third micro-robot 153 will have power supply 169 and others. Next, these micro-robots 151, 152, 153 will be normally isolated and move in the body cavity through wireless signal and others from the external control means. However, it is shown in figure 30 that they can be linked in a single body (comprehensive unit). Next, they can exchange energy and signal.

Therefore, the practical application example is given in figure 31. That is, the inclining bond edge will have three-dividing electromagnet 171 whose polarity is reverse to those of the pair. Therefore, the position will never distort during docking. Next, bond edges on both sides will have extruding connector 172 for electric signal, LED 173, and power supply connector 174. On bond edges on the rear are concave connector 175, 176, 177, respectively. Electric signal transmitting connector 172 will connect each driving circuit. The electric connector 174 will connect each power supply. In addition, concave connector 176 has optical receiving sensor 178. LED 173 and optical receiving sensor 178 will give accurate position by matching the axial lines when micro-robot 152, 153 on the back are at approaching distance through inductive signal of micro-robots 151, 152 on the front.

Therefore, when these are used, the micro-robots 151, 152, 153 will go out of intake of the target body cavity 183 e.g. urinary duct, by passing channel 182 of the endoscope 181. Next, the initial micro-robot 151 will be fed to the target body cavity 183 by means of remote control, and allowed to crawl to advance automatically. Here, the micro-robot will examine affected zone, and deliver the next micro-robot 152 that matches with healing purpose. Furthermore, if healing time is extended, micro-robot 153 will be delivered to supply large amount or energy or power source.

Furthermore, figure 32 and figure 33 show another format of the micro-robot. In figure 32, the micro-robot also contains ultrasonic oscillator 194 for observing and cruising, and driving motor 195. In figure 33, the micro-robot 196 has injection needle 197, and the linking micro-robot 198 has medicine tank 199.

[Effects of invention]

The endoscope as described above will be proper to use at minor gravity or non-gravity space while simplicity of inspection, low penetration, and larger inspection scope will be expected.

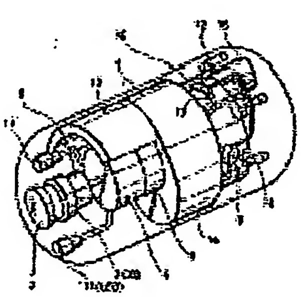
4. Brief explanations of drawings

Figure 1 to figure 3 show the first application example in this invention. Figure 1 shows outlines perspective view of the endoscope in this invention. Figure 2 shows the block diagram, and figure 3 the time chart during driving time. Figure 4 shows outlines of perspective view of the second application example of endoscope in this invention. Figure 5 shows its block diagram. Figure 6 shows outlines of perspective view of the third application example of endoscope in this invention, figure 7 its block diagram. Figure 8 shows outlines of perspective view of the forth application example of endoscope in this invention.

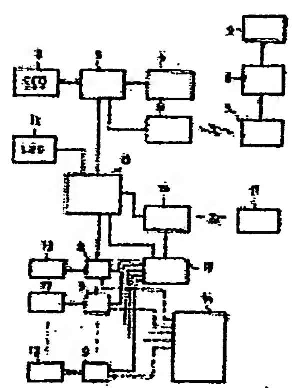
Figure 9 shows its block diagram. Figure 10 to figure 13 show the fifth application example in this invention. Figure 10 shows side view of the application state, figure 11 explanatory sketch of self-cruising leg, figure 12 the plane view of the self-cruising leg, and figure 13 the cross-section of the self-cruising leg. Figure 14 to figure 16 show a deformed application of the self-cruising leg. Figure 14 shows perspective view of self-cruising leg motion, figure 15 the plane view of the self-cruising leg, and figure 16 the cross-section of the self-cruising leg. Figure 17 to figure 19 show cross-section of another self-cruising leg. Figure 20 shows outlines of perspective view to show another application state of the invention. Figure 21 show outlines of perspective view of another application of the invention as well. Figure 22 shows outlines of another application state. Figure 23 shows perspective view of the medical micro-robot. Figure 24 and figure 25 show its block diagram. Figure 26 shows another deformed application block diagram. Figure 27 shows perspective view of another medical micro-robot. Figure 28 show its block diagram. Figure 29 and figure 30 also show perspective view of another medical micro-robot. Figure 31 shows perspective view of its enlarged end. Figure 32 and figure 33 show perspective view of robot in another deformed application.

1 ...Housing, 2 ...Objective lens, 11 ...LED, 12 ...Nozzle, 14 ...Tank, 15 ...Receiver, 21 ...Piezoelectric sensor, 25 ...Fan, 26 ...Motor, 38 ...Nozzle

Written by: Atsushi Tsuboi, Patent Attorney



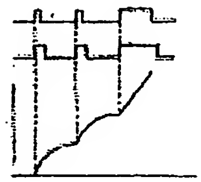
[Figure 1]

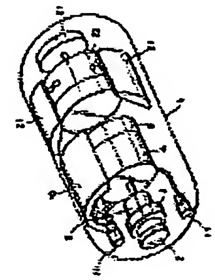


[Figure 2]

[*Translated by number*]
1 Housing 2 Objective lens 4 Control unit
5 CCD driving circuit 6 Image transmitter
9 Valve 12 Nozzle 13 Power supply
14 Compressed air tank 15 Receiver
16 Valve controller

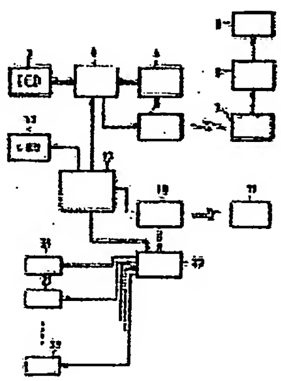
4 Control unit 5 CCD driving circuit
6 Image transmitter 7 Receiver outside the body
8 Image circuit 9 (upper) Monitor
9 (lower) Valve 12 Nozzle 13 Power supply
14 Tank 15 Receiver 16 Valve controller
17 Transmitter outside the body

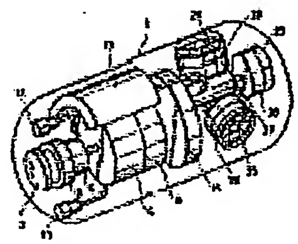




[Figure 3]

[Figure 4]

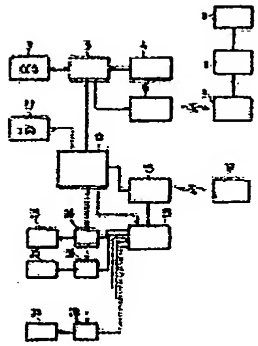




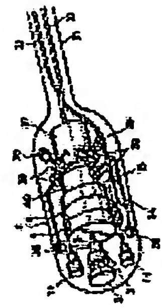
[Figure 5]

[Figure 6]

4 Control unit 5 CCD Driving unit 6 Image transmitter 7 Receiver outside the body 8 Image circuit 9 Monitor 13 Power supply 15 Receiver 17 Transmitter outside the body 21 Piezoelectric sensor 22 Piezoelectric sensor driving circuit

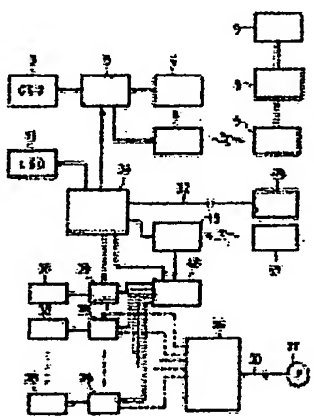


[Figure 7]

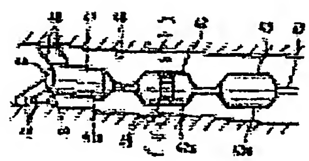


[Figure 8]

4 Control unit 5 CCD Driving circuit 6 Image transmitter 7 Receiver outside the body
8 Image circuit 9 Monitor 13 Power supply 15 Receiver 17 Transmitter outside the body 25 Fan
26 Motor 27 Motor driving circuit

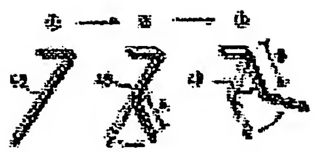


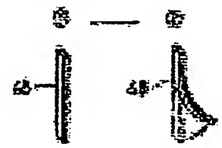
[Figure 9]



[Figure 10]

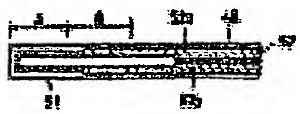
4 Control unit 5 CCD Driving circuit 6 Image transmitter 7 Receiver outside the body
8 Image circuit 9 Monitor 15 Receiver 17 Transmitter outside the body 34 Energy control unit
35 Power supply outside the body 36 Reserve tank 38 Nozzle 39 Valve 40 Valve controller

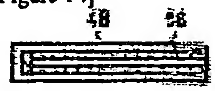




[Figure 11]

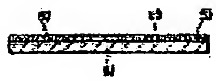
[Figure 14]

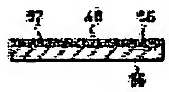




[Figure 12]

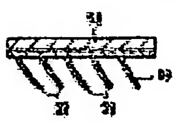
[Figure 15]

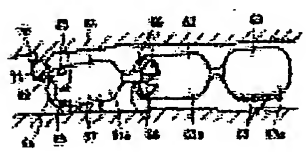




[Figure 13]

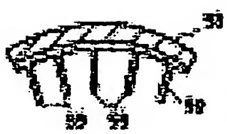
[Figure 16]

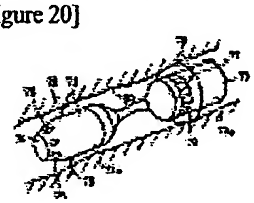




[Figure 17]

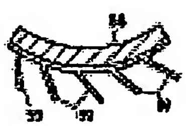
[Figure 20]



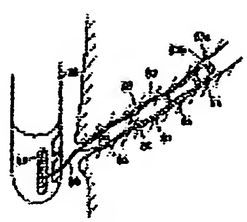


[Figure 18]

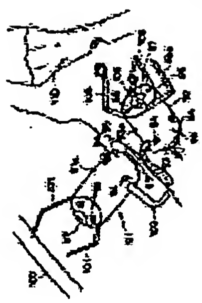
[Figure 21]



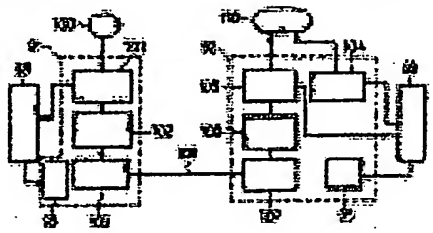
[Figure 19]



[Figure 22]

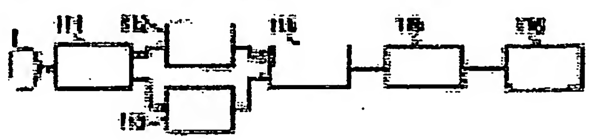


[Figure 23]



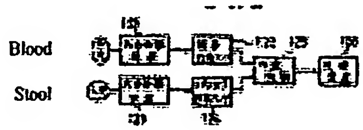
[Figure 24]

95 Propulsive unit 98 Operating unit outside the body 99 Operating unit outside the body 100 Artery 101 Blood collection manipulator 102 Blood storage tank 103 Bone removing manipulator 104 Composition separating unit 105 Bone healing manipulator 107 Bone synthesis unit 108 Artificial bone outlet unit 110 Bone



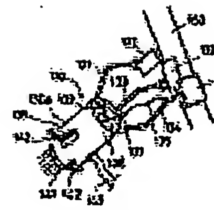
[Figure 25]

1 Blood 111 Composition separating unit 112 Glucose storage tank 113 Oxygen storage tank 114 Oxidizing decomposition unit 115 Motor 116 Propulsion unit

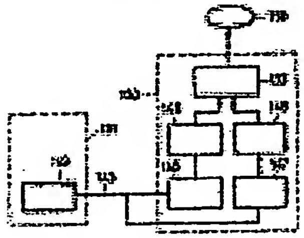


[Figure 26]

121 Composition separating unit 122 Oxygen storage tank 123 Composition separating unit 124 Methane storage tank 125 Internal combustion mechanism 126 Propulsion unit

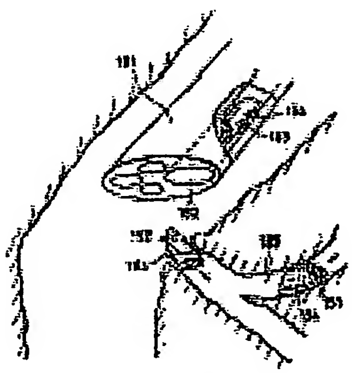


[Figure 27]

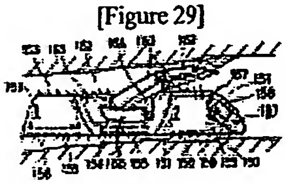


[Figure 28]

133 Manipulator 145 Protein film synthesis unit 146 Protein film outlet pump 147 Protein thread synthesis unit 148 Protein outlet pump 149 Composition separating unit 150 Artery

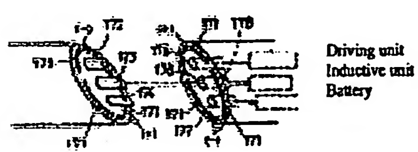


[Figure 29]

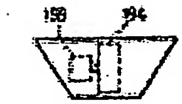


[Figure 30]

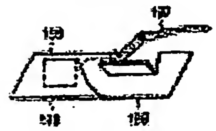
1 Battery 2 Transmitter



[Figure 31]



[Figure 32]



[Figure 33]

1 Fluid storage tank

Continued from page 1:

(51) Int. Cl5			Classification code	In-house control No.
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//	A 61 B	8/14		9052-4C
	A 61 F	2/06		7603-4C
		2/28		7603-4C
	B 64 G	1/66	Z	8817-3D

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